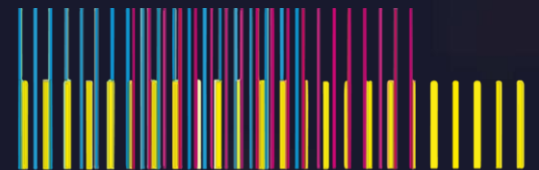


PI Algorithms (Stochos) in Ansys optiSLang: Unveiling the Current and Future Advancements

Anas Abdulhkim
22.06.23 Weimar

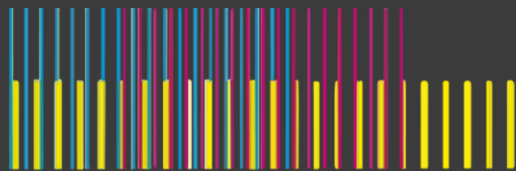
PI Probaligence GmbH



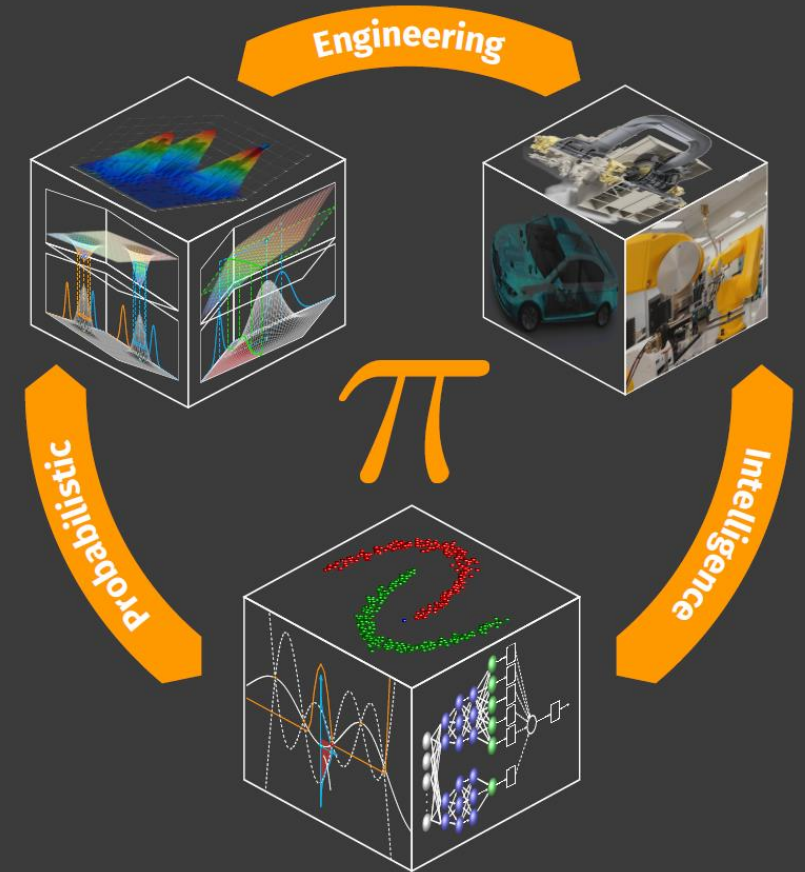
AUGSBURG
INNOVATIONS
PARK

The (short) story of PI founded in late 2018

- University spin-off for **research transfer**
- **Maintenance, support** and further **development**
- PI provides the **reliability** of an industry company and the **innovation** of a research faculty



AUGSBURG
INNOVATIONS
PARK



PI Algorithms and Solutions

PI offers:

- Unique self-developed ML algorithms
- **(Customized) software solutions**
(PI in Ansys optiSLang)
- Consulting
- Methods development
- Research partnerships
- Training courses for professionals

PI in Ansys optiSLang

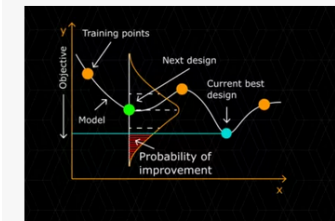
/ What's New

Set up and run simulations in [Ansys Discovery](#) for a wide range of industries and applications faster and easier than ever before with new multiphysics capabilities, performance improvements and dynamic collaboration updates.



Orchestrate and Automate with New Nodes

Engineers can create sophisticated toolchains using the new nodes for [Ansys LS-Dyna](#), [Ansys SpaceClaim](#), [Nastran](#) and [Ansys ModelCenter](#) and improved nodes for [Ansys Electronics Desktop](#) and [Ansys Workbench](#).



New Partnership with Probaligence GmbH

[Ansys optiSLang](#) continues to deliver the best of design understanding and optimization algorithms through a partnership with Probaligence, which provides AI/ML technology to increase the breadth of state-of-the-art optimization.

optiSLang App Generation Wizard

optiSLang App Test Run

Perform local optiSLang App Test-Run

→ Test-Run

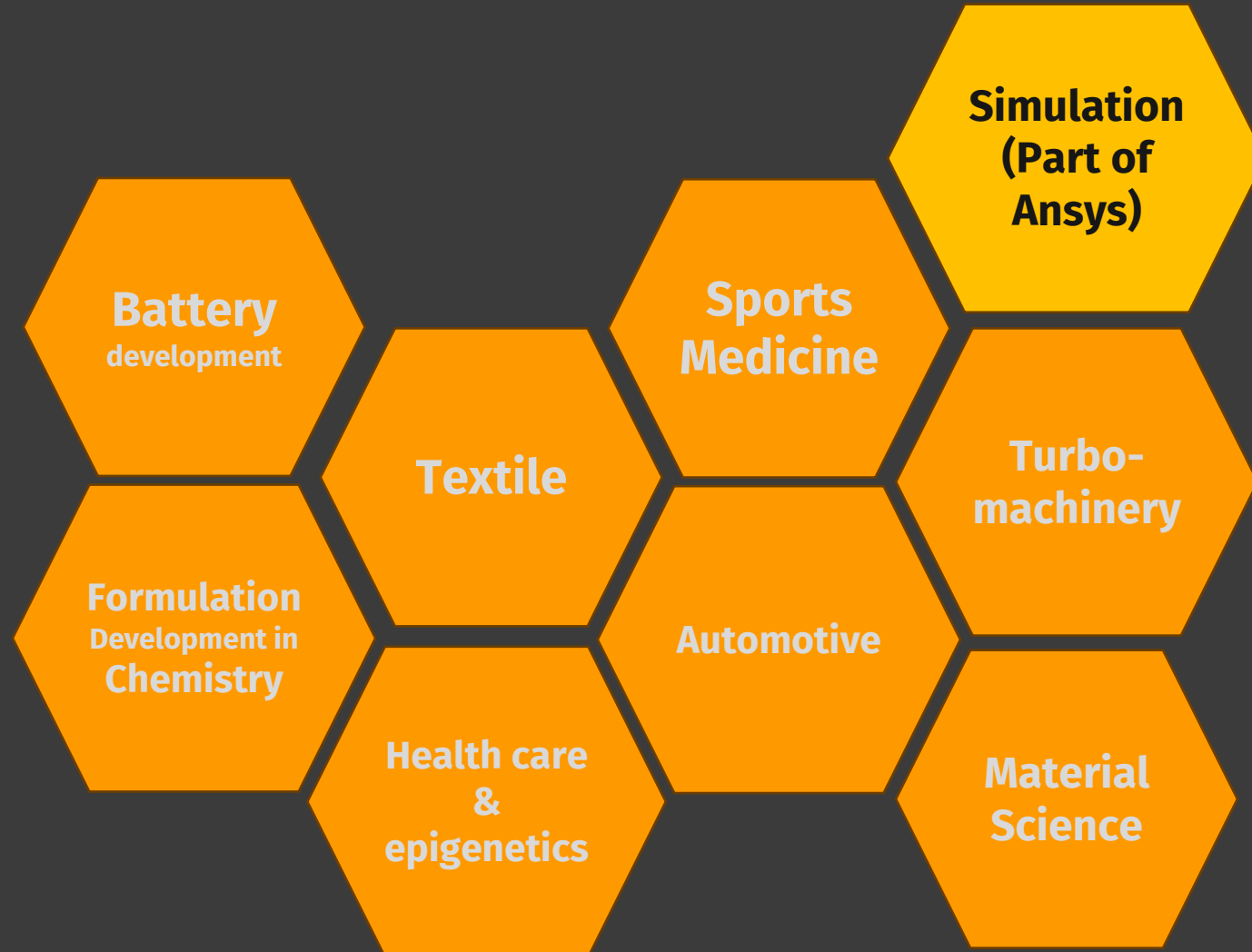
Perform local optiSLang App Test-Run

Desktop Apps from optiSLang's App Generation Wizard

Simulation and optimization experts can build automated workflows, create apps from these automations, and test their apps locally on a desktop before deploying.

In the fields of **design of experiment**, **probabilistic machine learning**, **stochastic analysis** and **optimization**.

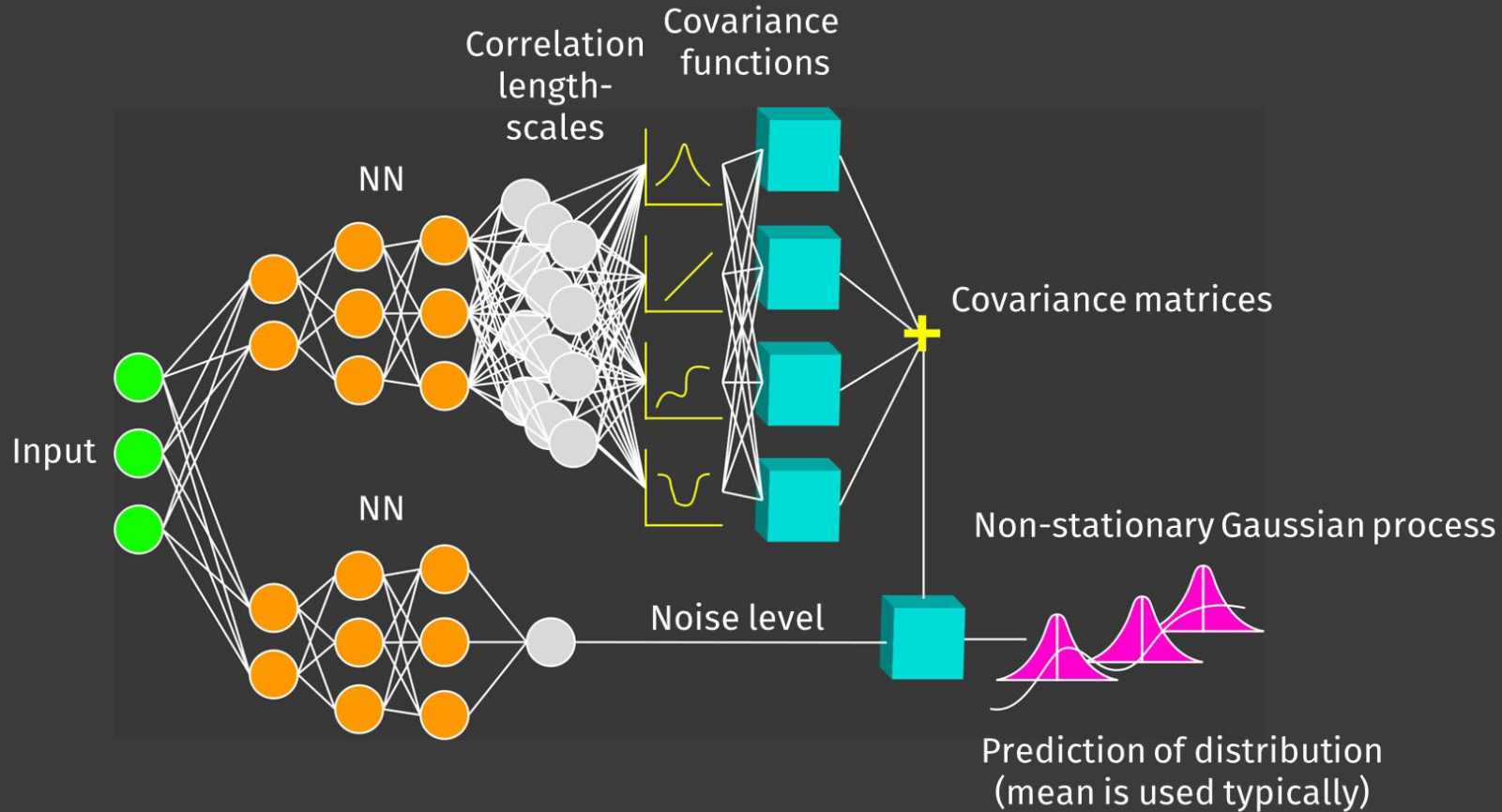
Excerpt of our industries



Our machine learning model:

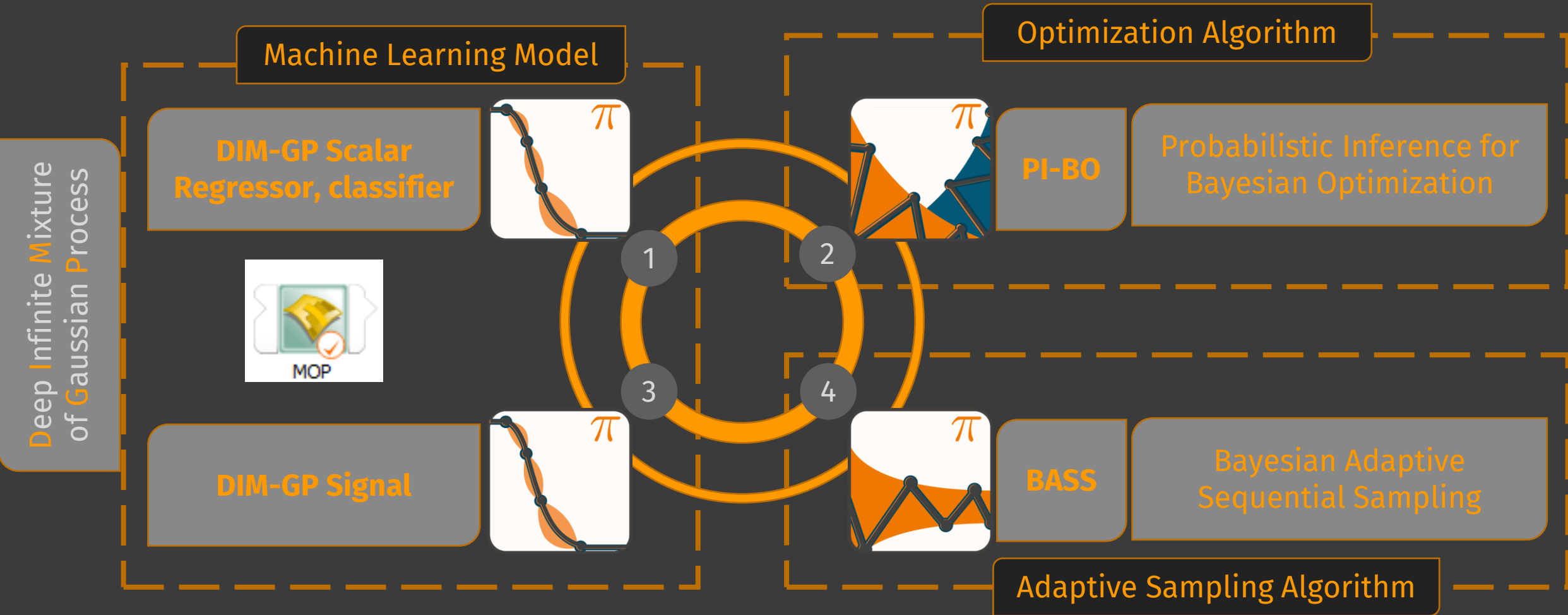
**Deep Infinite Mixture of
Gaussian Processes
(DIM-GP)**

Neural networks + Gaussian process = DIM-GP



- **Combined strength of NN + GP**
- **No hyperparameters**
- **Small dataset/ large parameters**
- **Automatic kernel engineering**
- **Scalable like NN**
- **Many tasks**
- **Can be used for any kind of data shape**

Overview of Stochos optiSLang



Key Advancements in Stochos optiSLang

- **PI-BO Advancements**

- Basic GUI
- Advanced
- New settings

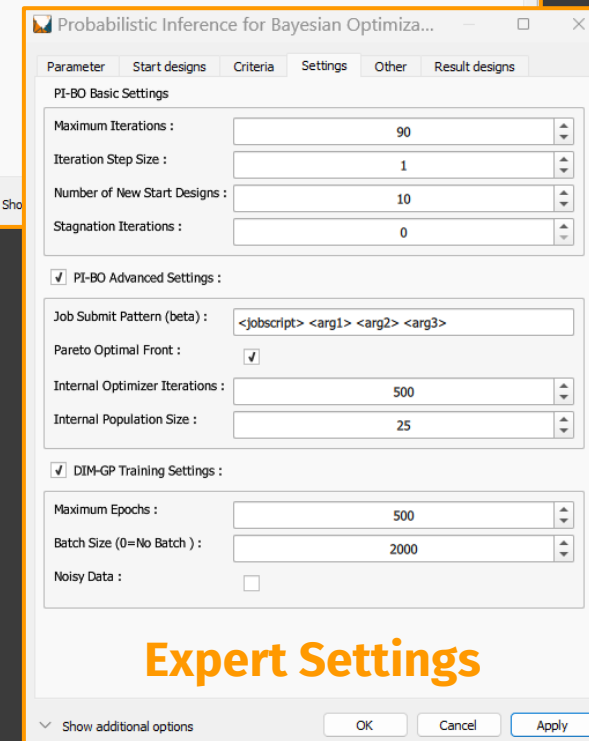
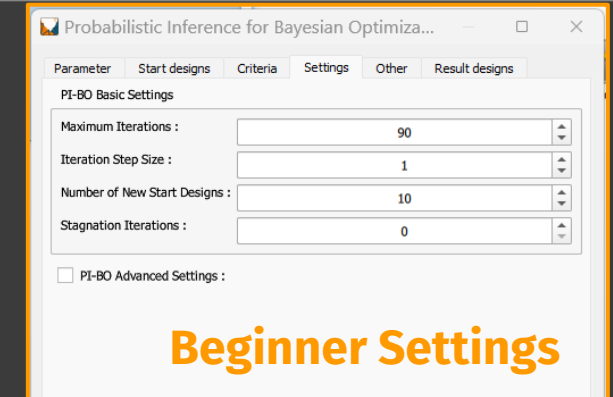
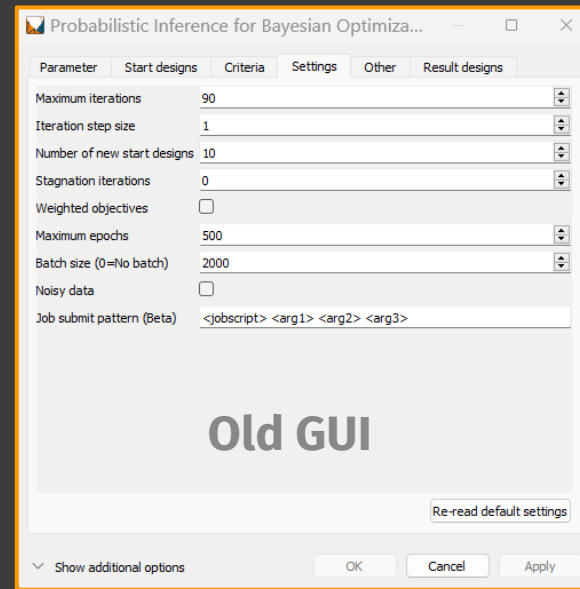
- **DIM-GP Signal Advancements**

- Exposing signal statistics curves to post-processing
- Exposing signal parameter correlations curves to post-processing

PI-BO Advancements

- **Simplified GUI**

- Beginner friendly settings:
 - Focus on basic/universal optimization's settings.
 - Easier and faster for beginner users.
- Expert settings:
 - Accessing more **PI-BO** settings.
 - Improving results of complex problems.



PI-BO Advancements

- Exposing more settings:
 - Internal Optimizer Iterations:
 - Internal Population Size:
 - Improving results in case of increasing the number of constraints and objectives of the optimization problem.

Probabilistic Inference for Bayesian Optimiza...

Parameter Start designs Criteria Settings Other Result designs

PI-BO Basic Settings

Maximum Iterations : 90

Iteration Step Size : 1

Number of New Start Designs : 10

Stagnation Iterations : 0

PI-BO Advanced Settings :

Job Submit Pattern (beta) : <jobscript> <arg1> <arg2> <arg3>

Pareto Optimal Front :

Internal Optimizer Iterations : 500

Internal Population Size : 25

DIM-GP Training Settings :

Maximum Epochs : 500

Batch Size (0=No Batch) : 2000

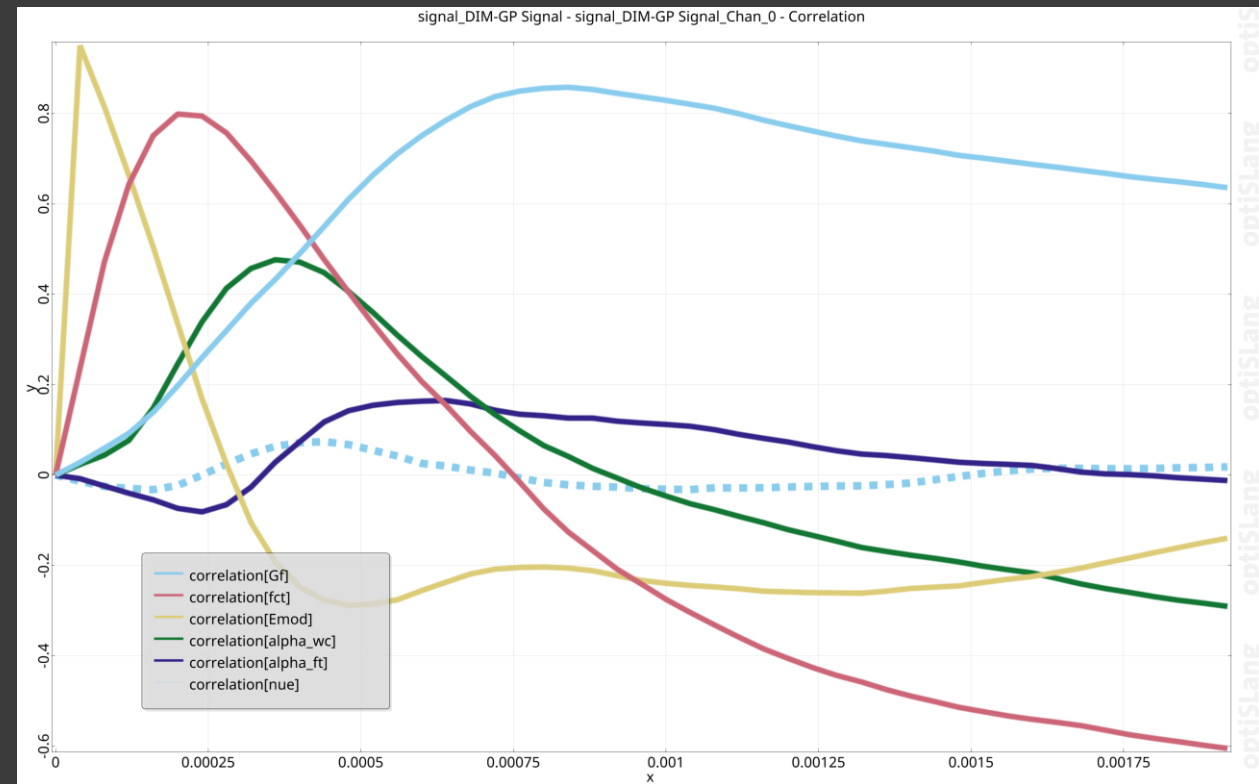
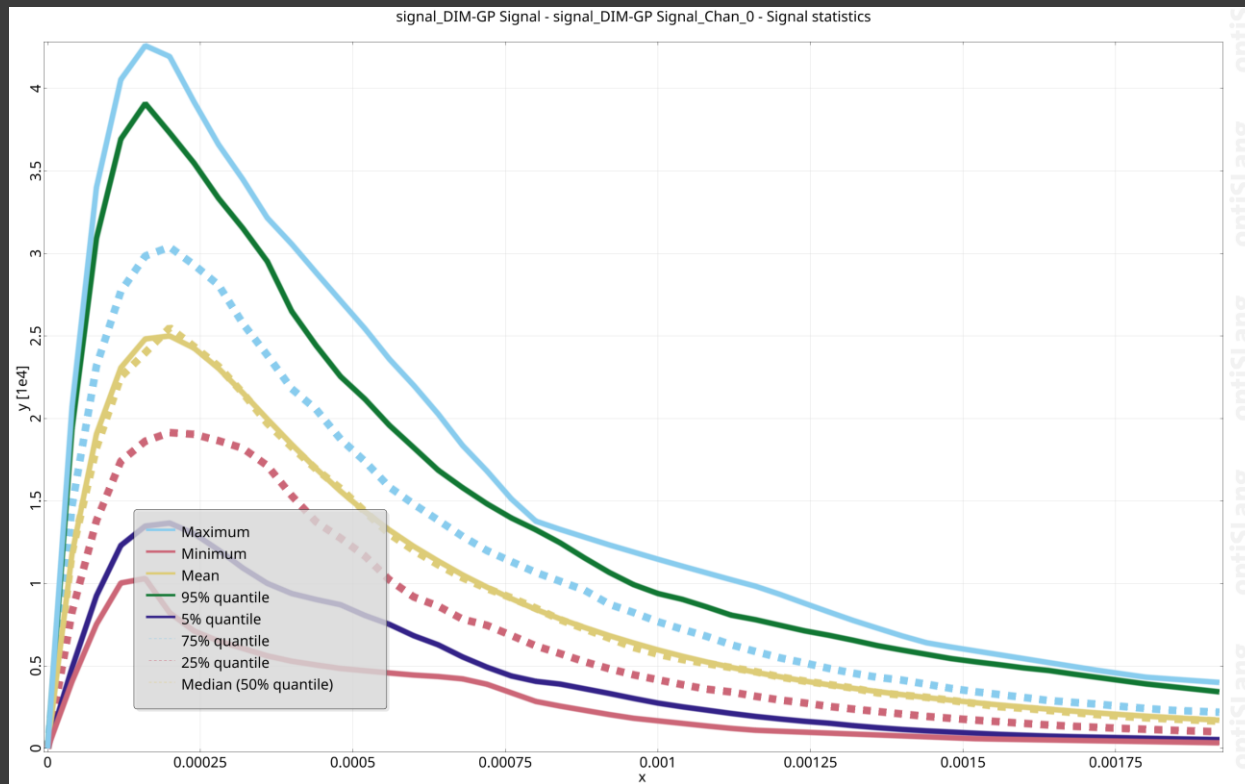
Noisy Data :

▼ Show additional options

OK Cancel Apply

DIM-GP Signal Advancements

- Visualizing **signal statistics curves**
- Visualizing **parameter – signal correlation curves.**



New Advancements on the Horizon

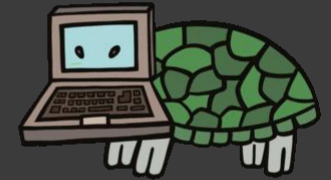
PI-BO Upcoming key Advancements

- Main Customers Feedback:

PI-BO is **Good** but **slow**



Good



slow

- Our Target:

Good and **Faster**



Good



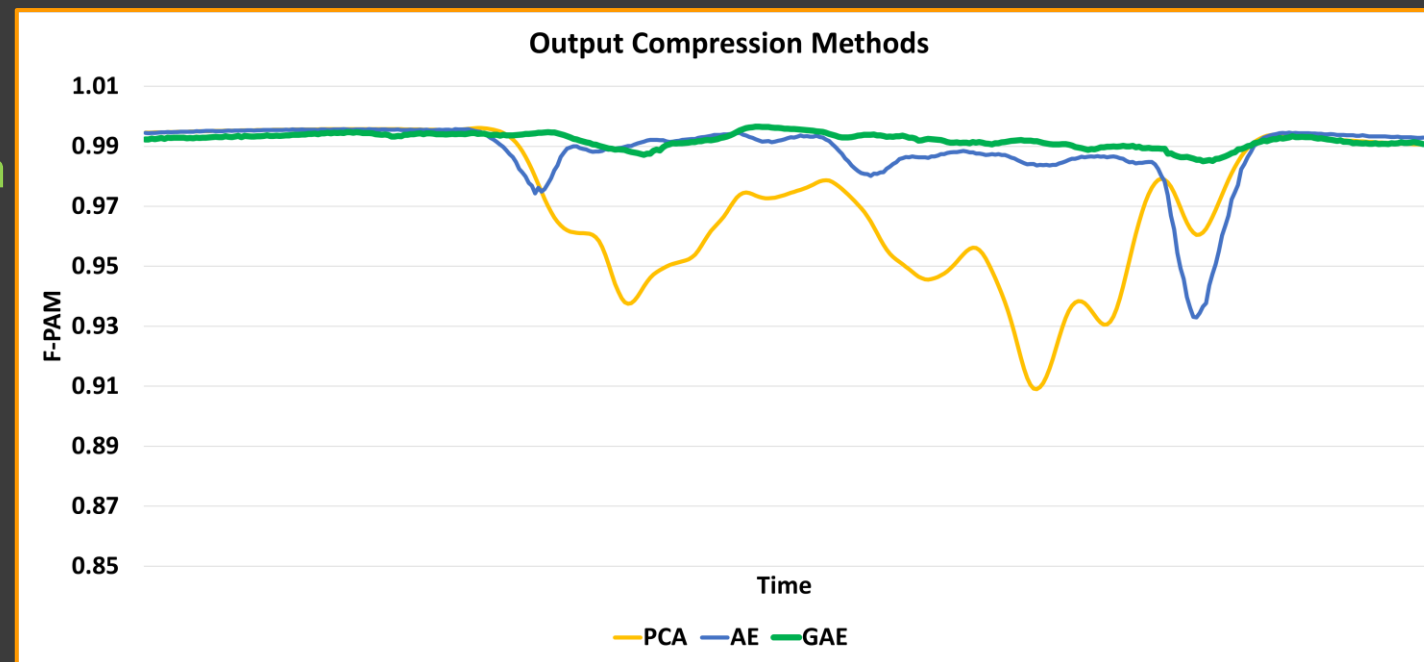
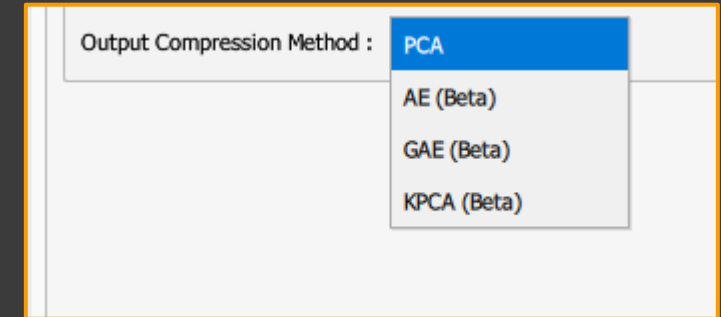
Faster

PI-BO Upcoming Advancements

- Parallel computation of the constraints and objectives
- Exposing more advanced settings:
 - Efficient batches
 - More efficient way of estimating multiple points for the adaptation.
 - Choosing as many points as related to the current state of the optimization.
 - Local search
 - Activating local optimization during the search for the next candidate.

DIM-GP Signal Upcoming Advancements

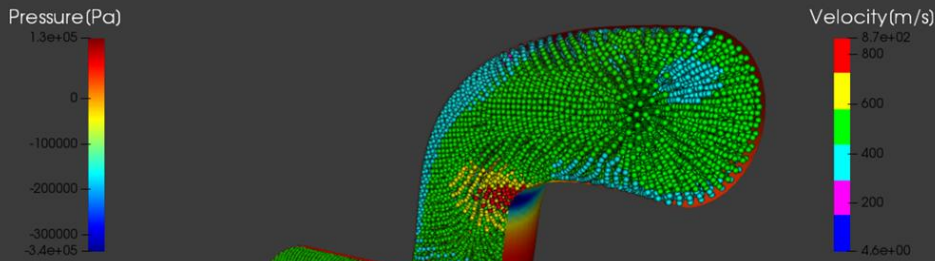
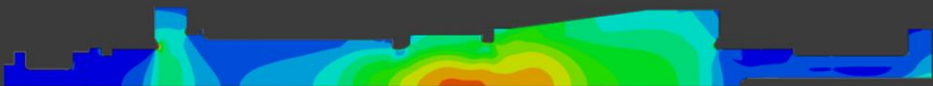
- Output compression methods out of beta:
 - Those methods can dramatically outperform the default (PCA)
- Cross-correlation between channels:
 - Improve the performance of the model in case of signals of multiple-correlated channels.
 - Reducing the trained models and computational time.



DIM-GP Upcoming Advancements

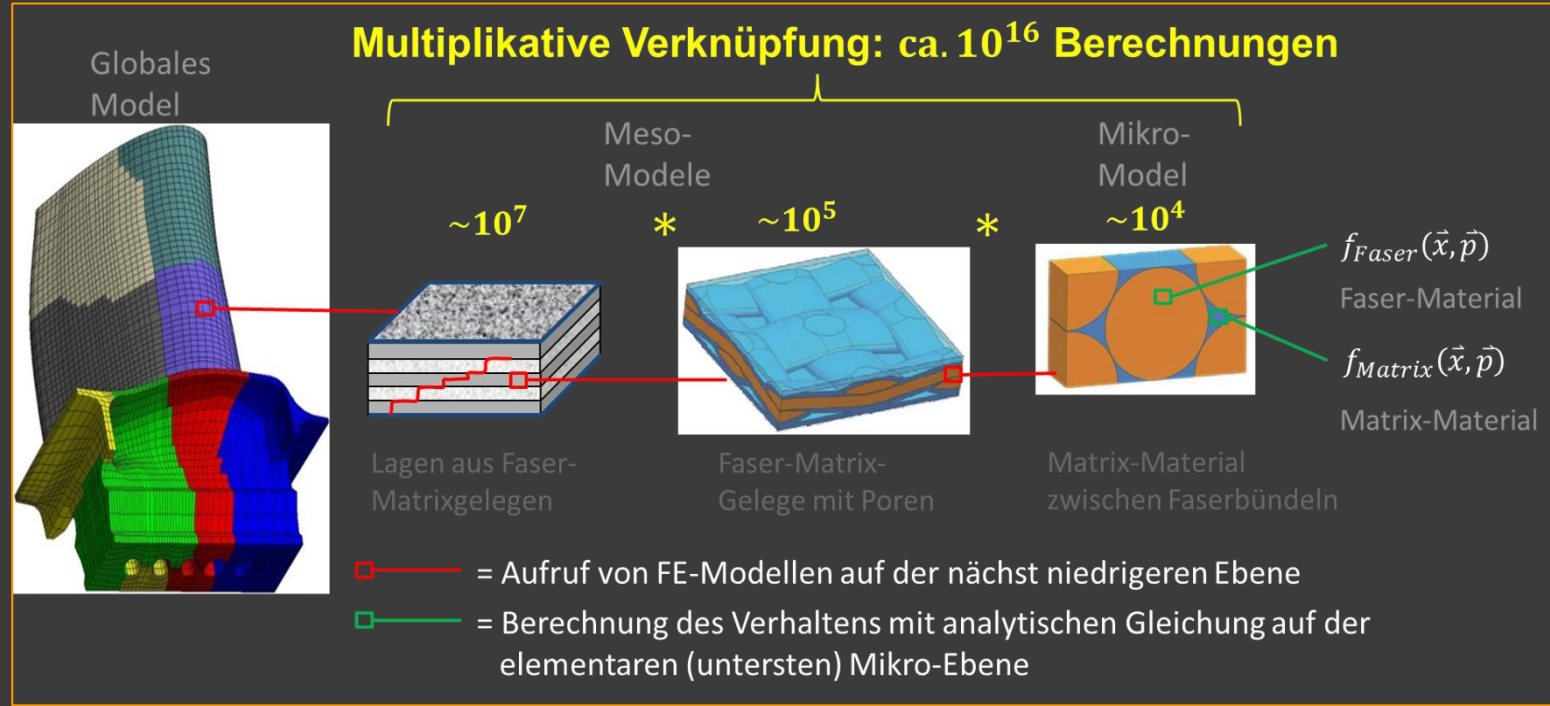
- DIM-GP for n-dimensional outputs
 - DIM-GP is capable to approximate n-dimensional output

Multi-output (live FEM / CFD):



Multiscale FEM

Multiplikative Verknüpfung: ca. 10^{16} Berechnungen



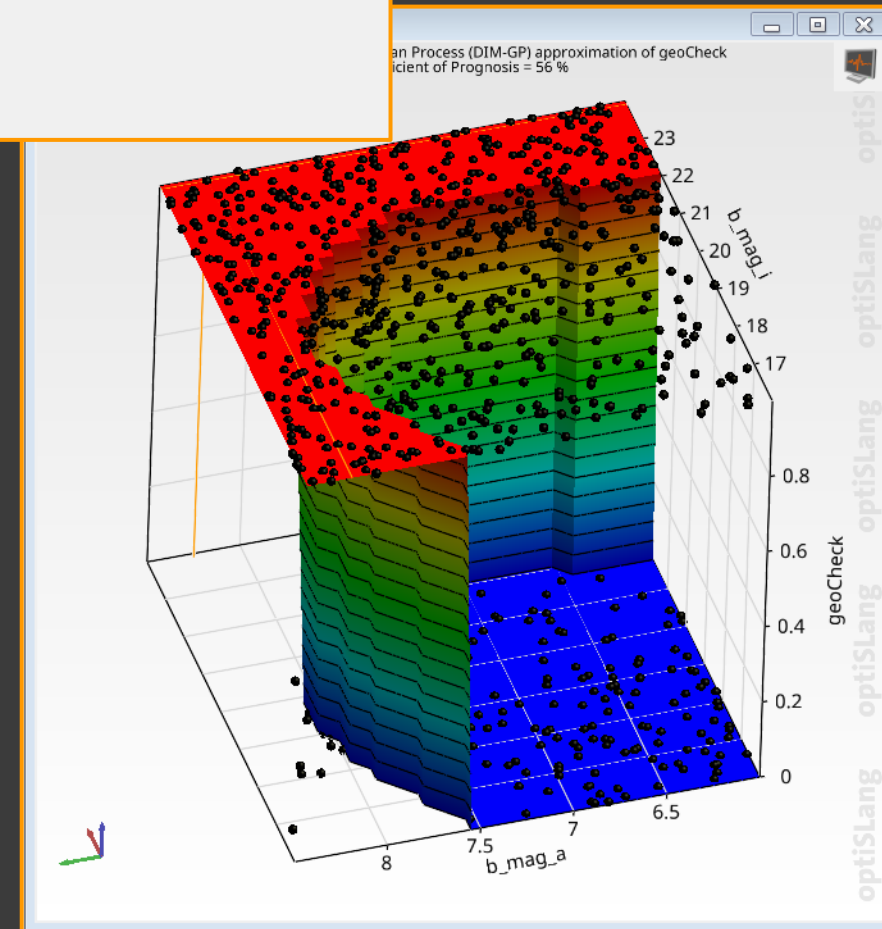
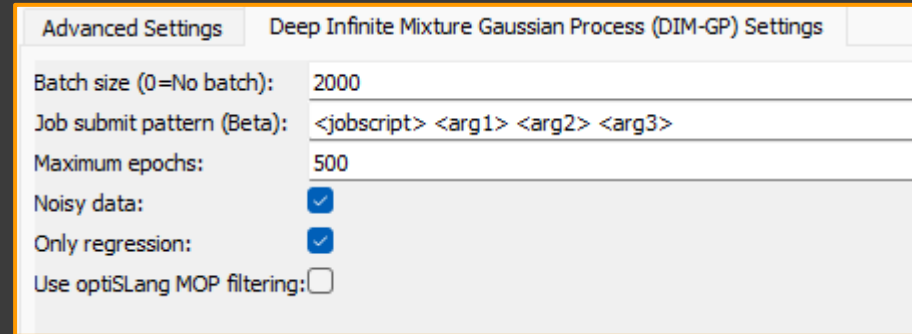
DIM-GP Scalar Upcoming Advancements

- **Parameter Filtering:**

- Reducing the overhead of using MOP filtering.

- **Classification Metric:**

- Classification within optiSLang is yet possible.
- But a realistic metric for classification task is required.



Thank you for Support and Feedback

ANSYS Development team

Mr. Roland Schirrmacher (BOSCH)

Contact

M.Sc. Anas Abdulhkim

anas.abdulhkim@probaligence.de

Dr.-Ing. Kevin Cremanns

kevin.cremanns@probaligence.de

www.probaligence.de



Questions?